ENGINEERING EDUCATION

Bulletin of the

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee.
P. F. Walker, Chas. F. Scott, F. L. Bishop, *Editor.*

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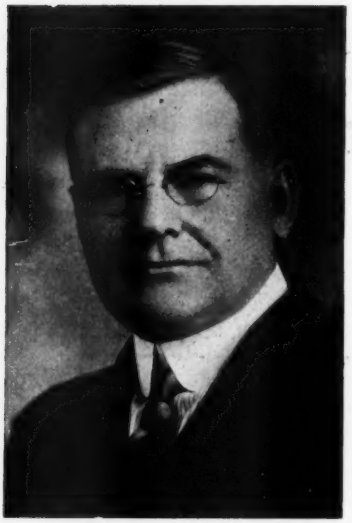


PERLEY F. WALKER.

President Walker graduated from the University of Maine in 1896 with the degree of B.M.E. He later received the degree of M.M.E. from Cornell. He left the Newport News Ship Building Company to accept the position of Head of the Mechanical Department at the University of Maine. In 1904 President Walker went to the University of Kansas as Professor of Mechanical Engineering, which title he still holds. In 1913 he succeeded Frank O. Marvin as Dean of the School of Engineering.

Dean Walker has carried on his professional engineering work with various concerns, chief among them being the large oil and gas producing companies in Oklahoma and Missouri.

In August, 1917, Dean Walker was commissioned Major of Engineering in the U. S. Army and assigned to the 314th

Engineers of the 89th Division. As Lieut. Colonel he was sent to the 109th Engineers at Camp Cody and in August 1918 was commissioned Colonel of Engineers.

Dean Walker is one of the representatives of the A.S.M.E. on the American Engineering Council, a member of the Executive Board of the Council, and a member of the special investigation committee on the storage of coal. He is Past-President of the Kansas Engineering Society, a member of A.S.I.E., the S.A.M.E., The Military Order of the World War, the American Academy of Political and Social Science, Sigma Xi, Tau Beta Pi, Sigma Tau, and Phi Gamma Delta.

THE THIRTY-SECOND ANNUAL MEETING, UNIVERSITY OF COLORADO, JUNE 25–28, 1924.

The preliminary program for the annual meeting has been mailed to all members and to others interested. One of the outstanding features of this meeting is bound to be the discussion of the work of the Board of Investigation and Coördination by the Director, W. E. Wickenden. He has visited a large number of institutions and has his program well under way. The Board will hold one or two session during the convention and perfect plans for furthering the work.

Both of the non-engineering members of the Board, Carl E. Seashore, Dean of the Graduate School of the State University of Iowa, and Frank Aydelotte, President of Swarthmore College, will give addresses the second day of the convention. At the same time C. R. Mann, Director of the American Council on Education, who conducted the original study of engineering schools, will be present and give an address. The report on attendance at engineering schools will be another important contribution.

The early sessions of the convention will be devoted to mining and metallurgy, the first session being held at Golden at the Colorado School of Mines, the second session at Boulder.

A statement concerning railroad fares from different points of the United States has been mailed to all members east of the Mississippi River. The various railroad companies entering Denver have mailed material to all members of the Society.

The social side of the convention is adequately provided for and I am sure we can say at the end of the convention "A good time was had by all."

The local committee has arranged a dinner for the first meeting of the Council. This will be held at the Boulderado Hotel at 6:00 P.M., Wednesday, June 25th.

On Wednesday evening, June 25th, there will be an Organ Recital by Dr. F. W. Chace in the Macky Auditorium. Fol-

lowing this recital, Mr. E. G. Fine will give an illustrated lecture on "Rambles Through the Rockies." A Get-Acquainted meeting will follow the lecture.

On Thursday noon, June 26th, a luncheon will be served at the Country Club. There will be a charge of $1.00 for this luncheon.

Thursday afternoon at 4:00 P.M., there will be an automobile drive over the mountains to Boulder Canon and a Beefsteak Fry will be the chief attraction at the end of the drive. A Campfire Smoker and Round Table will close the day.

On Friday, June 27th, at 12:30 P.M., there will be a luncheon in the Chautauqua Dining Hall.

President and Mrs. Norlin will be "at home" to the members and guests of the Society from 4 P.M. to 6 P.M. on Friday, June 27th.

On Friday, June 27th, at 7 P.M., the annual dinner will be held in the Boulderado Hotel. This dinner will be informal. The charge for this dinner is $2.00.

On Saturday, June 28th, there will be a trip to the Lakeside Power Plant (now under construction) of the Public Service Company of Colorado. They are also providing a complimentary luncheon.

While the convention is in session, the Ladies' Committee will provide automobile trips, teas, and other entertainment for visiting ladies and children. A program for the ladies will be furnished at the time of registration.

The region surrounding Boulder is one of great natural beauty, and there are many interesting excursions which may be made by automobile or on foot. The local committee will furnish information and endeavor to arrange for such trips during the convention and for the Saturday afternoon and Sunday following.

Automobile trip to Estes Park.—Leaving Boulder Saturday afternoon and returning to Boulder Sunday or later if desired. Cost for transportation, $5.00 to $8.00, depending upon the number taking the trip, and upon the exact route

chosen. Excellent hotel accommodations may be secured in the park at not to exceed $5.00 per day, American plan.

The University operates two mountain camps; one six miles from Boulder at an altitude of 7,800 ft.; and one 28 miles from Boulder at an altitude of 9,500 ft. The farther camp is only six miles from the Continental Divide and Arapahoe Glacier. Camp conditions prevail. The charges are $14.00 per week. Transportation to nearer camp is $2.00 for the round trip, and to the farther camp, $4.00. Members may spend as much time at these camps as they desire.

Those who expect to spend any time in the mountains should provide themselves with suitable hiking clothes.

Golf links are available. Guests should bring their clubs. Tennis courts are available.

SUGGESTIONS REGARDING PROPOSED CONSTITUTION OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

W. G. Raymond, *Chairman*, C. S. Howe and C. C. Williams.

Article I.

Name and Object.

1. The name of this organization shall be the Society for the Promotion of Engineering Education.

2. The objects of this society shall be the promotion of the highest ideals in engineering education with respect to administration, curriculum, and teaching work, and the maintenance of a high professional standard among its members. The means to this end shall be the holding of meetings for the reading and discussion of professional papers, and the publication of papers, discussions and communications as may seem expedient.

Article II.

Membership.

Membership in the Society shall be of two general classes, Institutional and Individual.

Institutional members shall be educational institutions giving instruction in engineering and scientific subjects.

Individual membership shall be of two classes, Active and Honorary. It shall comprise those persons who occupy or have occupied responsible positions in the work of engineering instruction, engineering practitioners, and other persons interested in engineering education.

Honorary Members of the Society shall be such persons as may be recommended by unanimous vote of the Council in a letter ballot to be taken by the Secretary on the recommendation of two members of the Society as provided hereinafter for individual members. Councilors not heard from within one

month from date of mailing the ballots will be counted in favor of the candidate. Honorary Members shall not have the right to vote, shall not be eligible to office, and shall not be required to pay any fees or dues.

A member in good standing may become a life member, exempt from all future payments for dues, by a single payment of an amount equal to twenty times the annual dues. Such payments received by the Society shall be placed in a separate fund known as the Life Membership Fund. The interest earned on this fund shall be used as current income.

Individual members who have been in good standing for twenty-five years, or more, and have retired from active professional life, or who have reached the age of 65 years may be designated life members by vote of the council, and shall be exempt from the payment of dues thereafter.

The name of each candidate for active individual membership shall be proposed in writing to the Secretary by two members by whom the candidate is personally known. The proposal shall state the qualifications on which it is based. The name of a candidate for Institutional membership shall be proposed by any member familiar with the work of the institution on receipt of an application signed by a responsible officer thereof.

An affirmative letter ballot of three-fourths of those members of the Council whose vote reaches the Secretary within one month from the time of sending out the name of the candidate shall elect. Such letter ballot elections occurring before February 1, shall be credited to the previous annual meeting and dues shall date from that time; elections occurring after February 1, shall be credited to the next annual meeting and the dues for the remainder of the year shall be one-half the annual dues.

Article III.

Dues.

1. There shall be no admission fee.
2. The annual dues, including the subscription price of

the Journal, shall be $4.00 for individual members, and $25.00 for institutional members.

3. Dues are payable in advance at the time of the annual convention, and become delinquent at the end of the fiscal year for which they are assessed. Dues of new members are payable at the time of election, and become delinquent at the end of the fiscal year within which the members are elected.

4. Members in arrears one year shall be retained on the roll of the Society, but shall not receive publications until such time as all arrearages are paid. Members in arrears two years, and who have been duly notified by the secretary shall be dropped from the roll of the society until such arrearages are paid. The secretary shall notify all members in arrears one month previous to the close of the fiscal year. The fiscal year terminates the 30th day of June.

Article IV.

Officers.

There shall be a President, two Vice-Presidents, a Secretary, and a Treasurer.

Article V.

Council.

1. The Council of the Society shall consist of twenty-one elective members, one third of whom shall retire annually, and the officers and the past presidents of the Society.

2. Any member of the Society shall be eligible to election to the Council, provided that not more than one elective member shall be from any one institution.

Article VI.

Election of Officers and Members of the Council.

1. The officers and one third of the elective members of the Council shall be elected by ballot of the Society at the annual meeting.

2. There shall be a Nominating Committee consisting of the past presidents and the seven elective members of the Council retiring the following year, provided, however, that if, of this committee, the number in attendance at any meeting be less than five, the President shall make appointments so as to form a committee of five. The committee shall report to the Society at the business session, provided therefor in the program, nominees for officers for the ensuing year, and for seven councillors to serve for three years, and for councillors to fill vacancies that may occur.

Article VII.

Sections, Branches and Divisions.

1. A Section of the Society may be formed by members in two or more institutions or by the members within a prescribed territory. A Section may be formed in any locality by a temporary organization which shall become a duly authorized section of the Society upon the approval of the Council. Sections may determine their own form of organizations, but shall operate in conformity with the Constitution and By-Laws of the Society and shall make a report of their proceedings to the Secretary of the Society. Sections shall be self-sustaining.

2. A Branch may be formed in any institution by a temporary organization which shall become a duly authorized Branch of the Society upon approval by the Executive Committee. Branches may determine their own form of organization, but shall operate in conformity with the Constitution and By-Laws of the Society and shall make a report of their proceedings to the Secretary of the Society. Branches shall be self-sustaining.

Branches may coöperate with or be a part of other organizations having the same general purpose of this Society. The general purpose of Branches is to extend the interest in, and the discussion of, questions relating to the teaching of engineering students, and to bring to the Society at large, through

its publications, the activities in all institutions that will be serviceable to the members of the Society.

3. Papers and discussions presented before Sections or Branches shall be the property of the Society and may be published as Society proceedings if authorized by the Publication Committee. Permission to publish elsewhere may be granted by the Council on condition that the Society receives proper credit.

4. When approved by the Council, divisions may be formed by any group of members for the consideration of questions which relate particularly to that group.

ARTICLE VIII.

Meetings.

There shall be at least one annual meeting at such time and place as the Society at the preceding meeting, or the Council if the Society does not act, may determine. There shall be sectional and branch meetings as the members of the different sections and branches may determine.

ARTICLE IX.

Publications.

1. The formal publication of the Society shall be a monthly journal to be published from September to June inclusive. The Journal shall contain the proceedings of the annual convention and such other pertinent papers as may be submitted to, and approved by, the Publication Committee.

2. A bound volume of the Journal for each current year shall constitute the Proceedings of the Society. This will be sold to members who subscribe for it at a cost to be determined each year by the Executive Committee. Subscriptions for the Proceedings must be received in advance by the Secretary on or before October 15 of each academic year.

Article X.

Amendments.

This constitution may be amended by a two-thirds vote of those present at any regular meeting of the Society, provided that all members have been notified of the proposed amendment by notices, mailed from the Secretary's office at least thirty days prior to the regular meeting at which action is to be taken, and provided that the amendment shall have been approved by the Council by a two-thirds vote of the members voting by letter or voice.

By-Laws of the Society and Rules Governing the Council.

First. The Officers of the Society shall constitute a Committee to arrange for the annual meeting and to prepare a program for it.

Second. The President, the Secretary and the Treasurer shall constitute an Executive Committee which shall have charge of all matters relating to the expenditure of money of the Society, the making of appropriations to Committees and for other purposes, the making of contracts, the approval of bills, and also during the period between the meetings of the Council shall have charge of other business affairs of the Society.

Third. Expenditures of money may be made only in accordance with a definite appropriation or by direct vote of the Executive Committee.

Fourth. Reading of papers shall be limited to fifteen minutes each or to such other time as may be designated by the Program Committee, and abstracts of papers of about three hundred words shall be printed when practicable, and distributed in advance to the members.

Fifth. The time occupied by each person in the discussion of any paper shall not exceed five minutes.

Sixth. The President, the Secretary, and the retiring President shall constitute a Publication Committee, of which

the Secretary shall be chairman, to edit and have charge of the publication of the monthly Journal.

Seventh. The subscription price of the Journal shall be three dollars per year, payable in advance.

Eighth. Additions or amendments may be made to these By-Laws at any regular meeting of the Society, on the recommendation of the Council by a two-thirds affirmative vote of the Council and of the Society.

NOTES FROM THE FIELD.

BY WILLIAM E. WICKENDEN,

Director of Investigations.

During the past three months the writer has been engaged in a series of conferences with engineering faculties and with professional and industrial groups in an endeavor to ascertain what the live issues in engineering education are. In the background of all minds are the common problems of what to teach and how to teach it, but the answers appear to hinge on other questions requiring previous study.

There is the problem of how to get the right kind of young men into engineering colleges. This is a problem of both attraction and selection. The grounds on which young men choose to enter an engineering college and to pursue a particular course of study appear to be almost pathetically meager. Parents, high school teachers and others who are called upon for vocational or educational guidance, appear to be very inadequately informed about the duties and activities of engineering, the opportunities it opens up and the exactions it makes in the realms of body, mind and character. There is some evidence that young men of high promise are being counselled to avoid engineering and that it is represented as socially inferior to other educational programs and more likely to lead to routine jobs. Apparently the engineering profession owes itself more and better publicity. Possibly the S. P. E. E. should foster the preparation of attractive but discriminating information about engineering study and engineering life, and assist in its wide dissemination among high school teachers and seniors.

On the other hand, we have neither satisfactory criteria nor selective devices by which aptitude for engineering training and achievement may be detected or measured. Vocational psychology is making headway and ought soon to enable a

qualified expert to give a young man of sincere purpose a fair estimate of the odds of success or failure in following a particular educational program. No one but the student or his parents can properly decide what program shall be attempted, for no one else can assume the risks growing out of such a decision.

Practical progress toward the selection of students of proper aptitude is being made by the same but firm enforcement of entrance requirements, especially where individual counsel is given in addition. The possibilities of gain along this line are by no means exhausted, but where circumstances or external control have weakened the grip of engineering colleges on entrance requirements, particularly in mathematics, there is an undercurrent of feeling that gradual deterioration is observable in the student personnel.

The relatively high mortality in engineering courses tends to cast a great deal of doubt over the present standards of selection and admission. Taking the country as a whole, it seems probable that not more than forty per cent. of the men admitted to engineering colleges complete the courses and are granted degrees.

The large mortality referred to seems to indicate that perhaps half of the men admitted to engineering colleges could be better served by some other educational plan. There is a great dearth of specialized vocational schools intermediate between high schools and four-year colleges in the American scheme of education. The tax-supported colleges are giving serious thought to the proper means of providing such training. Probably industry should do more of it than at present. Junior colleges in city school systems are attempting it in some sections. Past experience in engineering schools seems to be against the plan of providing such training in institutions with four-year courses although the agricultural colleges have done so successfully. There is an oft-recurring proposal to organize engineering courses in two stages, and to make eligibility to the upper stage rest on the more exacting tests

than are now commonly applied between the second and third years.

At the other end of the scale, there appears to be a growing demand for more advanced professional training for a highly selected group of men. It is not clear that this advanced training should largely take the form of the usual post-graduate courses, which extend the period of college residence to five, six or seven years. Such training has been very fruitful in developing men for research and teaching positions and for the more individualized expert positions in industry, but there is much question whether it is preferable for men who lean toward the supervisory line positions rather than the expert staff positions in active life.

To reach its highest effectiveness advanced training must apparently be deferred until the graduate has had time to become oriented to his professional field and to discover his more specialized educational needs. It seems unlikely that many such men will leave their work or assume the expense involved in order to return to college as full-time graduate students.

Various adaptations of the coöperative principle of alternate periods of work and study and of the extension principle by which educational facilities are brought to men at their jobs are being tried out with graduates who have established themselves in active life and have discovered educational needs in advanced and specialized fields. Such plans are favorable to the development at favorably situated institutions of specialized centers of advanced training and research at which a high degree of coöperation from the industries can be developed. With the multiplication of such facilities for advanced training, especially where they are available to men in active life, much of the pressure toward specialization in undergraduate curricula might be relieved.

What numbers of men the engineering colleges should be training is a question of universal interest. No one organization has a wide enough touch with the problem to formulate

an adequate specification. The National Industrial Conference Board is fostering a survey along this line among a number of important groups in the manufacturing field beginning with the paper, rubber and textile industries. The American Railway Engineering Association and the large public utility groups are studying the matter in their respective fields. The field of highway transport has also received much attention.

A survey of occupational demands must necessarily be piecemeal and a matter of gradual accretion. The conduct of such studies is fairly certain to stimulate important sections of industry, which have been dormant toward technological progress, to an active search for trained men. Such action is certain to increase demand, and through competition, to improve the terms on which graduates may market their services. Employers may well be stimulated to a closer study of the utilization of engineering graduates and to means of accelerating their progress by training and early try-out under responsibility. Better use of the present number of graduates, especially in the earlier years, would be equivalent to an increase in the supply. Colleges, too, are likely to concentrate their efforts on " good risks " and to increase the output from present facilities by reducing student mortality. Only when such possibilities have been fully considered would we be justified in urging an increase in educational facilities on a large scale.

There is a wide awakening to the need of individualizing our teaching processes, so that gifted men may work nearer to capacity, slow-moving men may have a fairer chance to do honest and thorough work, and all grades of men may be led to assume more initiative for their training. There is a general desire to create a wholesome spirit of emulation in the intellectual work of the colleges, and equally, to work out a better valuation of the education to be had from participation in student activities. There is also a general interest in the possibility of establishing a diagnostic clinic to which students who are falling below standards may be sent for

expert individual examination with a view to locating any remediable difficulties before considering suspension or exclusion.

It is recognized also that the great majority of American engineering students have neither the inherited intellectual traditions nor the caste consciousness which characterize large student groups in the older British and European institutions, nor have they the urge of bitter economic competition. We are too largely dependent on group morale in sustaining our educational program to permit us to adopt the " take it or leave it " policy on a wide scale.

While engineering schools are interested in autonomous programs for selected individuals of maturity and initiative there is no evidence of a drift toward a loose elective system for the general mass. It seems apparent, however, that engineering teachers are coming to take the differences between curricula less seriously. The aim appears to be to afford the student certain broad options within each of which provision is made for giving the student certain fundamental resources of knowledge and a thorough grounding in the engineering method of attack and analysis. To do this thing well it appears that the logical inferences of the original choice should be carried out consistently, without a scattering of effort.

One hears much comment among both teachers and employers of the limited initiative of young engineering graduates. There is no complaint of their diligence, but it is often remarked that they need close supervision, have a tendency to seek complicated and difficult ways of doing simple things, and are slow to develop courage and enterprise in meeting unfamiliar situations. One eminent sage among engineering teachers has recently ascribed this alleged weakening of initiative to an excess of theoretical training—a proposition to which few of his colleagues are ready to assent. If there is any weakening of initiative the general tendency is to ascribe it to external conditions, but the suspicion exists widely that there has been a misdirected effort to make engineering edu-

cation exacting, which has merely succeeded in making it laborious, with a possible dulling of imagination and enterprise. There is a besetting temptation to substitute for exacting requirements in the realm of the student's thinking, a more mechanical set of exactions relating to the form and detail of innumerable themes, reports, exercises, problems and projects, so that academic success tends to become a matter of diligence.

The problem of the supply of engineering teachers, while less acute than a few years ago, remains a universal problem. It is partly a matter of salaries, but in no small degree a matter of status, of contact with professional life, and of avoiding dry-rot. In strong institutions, teaching salaries compare fairly well with the average salaries earned in active life by engineering graduates. Non-financial incentives and opportunities for other professional earnings are relied upon to make teaching positions attractive to superior men. Limited service facilities, immersion in detail duties, the geographical isolation of many of the colleges, the vast development of research and expert functions in industry, and the continual pressing of practice on the boundaries of theory, make it increasingly difficult for a young man to enter upon a teaching career and gradually establish himself as a recognized and expert authority. On the other hand, the importation of eminent practitioners to fill major professorships has its serious risks and limitations, and seriously discourages young men from entering the junior ranks of the profession.

What contribution should engineering colleges make to the training of young men for business and industrial management? No question is more widely agitated in engineering colleges. There is no disposition to abandon this responsibility outright to the rapidly growing colleges of business administration. The hypothesis on which many such schools appear to proceed—that there is a science or technique of management which exists as a thing apart, and which can be imparted independently of knowledge as to how economic

goods and services are actually produced—does not find ready acceptance among engineers. The need of better handling of economic problems and problems in human organization in their relation to engineering is everywhere admitted. The familiar didactic methods of teaching are not considered effective in this realm, and there is much inquiry as to the merits of the case system and other pedagogic devices for meeting these problems.

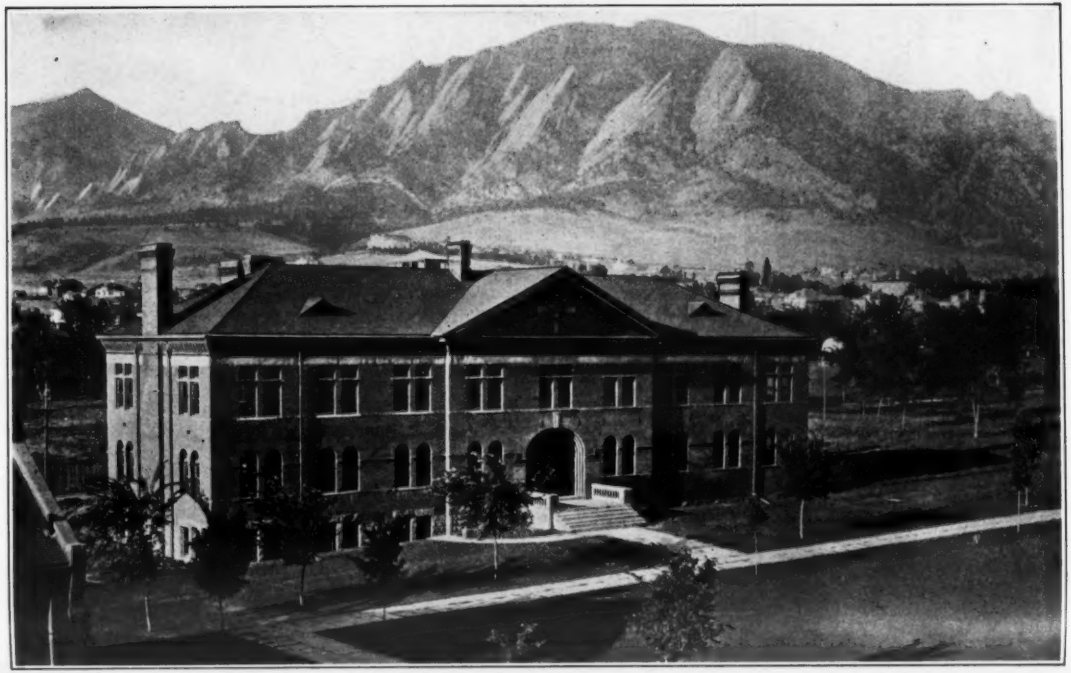
The question of costs in engineering education is becoming daily more pressing. When engineering schools come into competition with other schools, such as those dealing with business administration, in appeals for increased support, they are expected to assume the burden of proof growing out of their high unit costs. The propriety of giving such an expensive form of education to so many men of commonplace gifts is being questioned by more than one college executive. The same principle applies to various subjects of instruction, particularly where expensive equipment is used in the teaching of few men or for very brief periods. There is a tendency toward conservatism in duplicating the costly facilities possessed by other institutions, and reciprocity in the use of facilities by two or more institutions is on the increase.

Everywhere the queston of who should bear the costs of engineering training is being discussed. The average plant investment per engineering student is several thousand dollars, and the annual outlay, exclusive of interest and depreciation, averages $500.00 or more, and is nearly double this sum in a number of institutions. Should these costs be borne by the state, the individual student, the employing industries, or by private benefaction?

The wide publicity which is being given to the reorganization of Antioch College is directing much discussion toward the balancing of educational budgets. It is worthy of note that the pioneer institution operating on the coöperative plan and in many ways the most successful, the University of Cincinnati, makes a close approach to balancing current expenses

with income from fees. While its student body is not quite fully self-supporting from earnings, it approaches this condition far more closely than any other large student group. Could the principle of economic self-support for students and institutions become fully established in experience, there would be no artificial limits to the extension of higher education.

The list of live issues could be extended indefinitely—how to appraise student activities and best capitalize their educational values; how to make the research work of teachers and advanced students most effective as an educational force among undergraduates; how to capitalize to the full the industrial and economic environments of the several institutions; how to make the influence of great professional societies most effective; how to make young engineers more competent to deal with problems of human behavior; what is an effective cultural content for the engineering curriculum; how to present the engineering students a more adequate conception of the avenues and rates of professional progress which will be open to them; how to convince the American public at large of the possible gains to be had by entrusting the planning and execution of public works to engineers instead of politicians; how engineering colleges can contribute to the economic stabilization of great industries, such as transportation, whose use of engineering services and adoption of new and economical equipment is now limited by adverse conditions;—these will serve as examples.



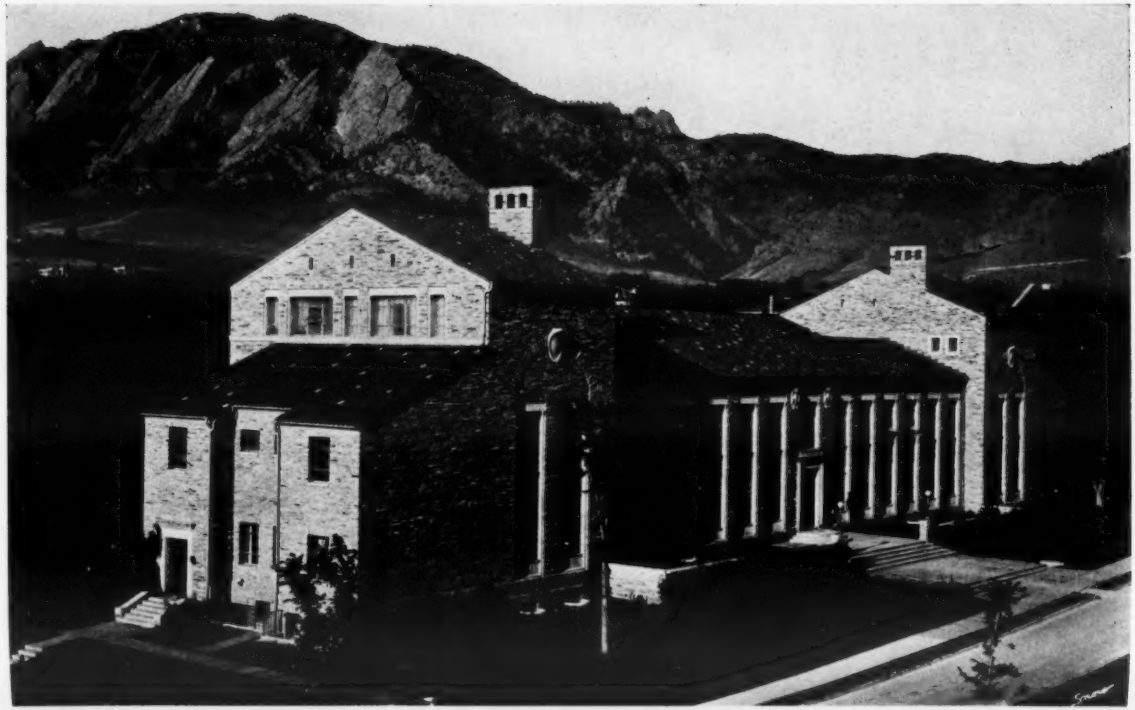
SIXTY YEARS OF EDUCATIONAL PIONEERING AND DEVELOPMENT—UNIVERSITY OF COLORADO AND COLLEGE OF ENGINEERING.

In June, 1924, the University of Colorado, with a faculty of 278 members and a total resident enrollment of 5,607 students, will have completed the fifty-third year of its existence. Incorporated by act of the Territorial Legislature in 1861, and established by the Constitution of Colorado in 1876 as a state university, it opened its doors on September 5, 1877, with two departments, normal and preparatory, with forty-four students, and with two faculty members: a president and a professor of Greek and Latin.

To whatever distinction the University of Colorado has already attained or may attain in the future, it is well that the humble beginnings of the school should not be overlooked in an attempt to define or appraise it. Unlike many of the large eastern colleges, founded and fostered by private benevolence and for the most part governed by one or another of the great religious bodies, the universities of the West have been provided for by public taxation. Peculiarly significant in this respect is the story of the early attempts at establishing the University of Colorado.

On October 26, 1861, a bill for an act to establish a university was introduced into the territorial legislature, and on November 7, the bill became a law. But these were restless days for the Territory. It was the days of the waning of the first mining enthusiasm, the days of distress caused by the Civil War; moreover, Indians were still troublesome, and so, far a period of sixteen years, the university existed only in name. Nine years after this first legislation, there was introduced into the House a bill for an act to amend the act of 1861. Interest revived, and a site was donated, comprising twenty acres lying to the east of the city of Boulder. The sum of $178.50 was spent upon improvements. The ground was surveyed, plowed, and harrowed. Contracts were let for plant-

ing of trees and for fencing the plot; but for some reason the trees were not planted, the fences were not put up, and the movement to establish a university again came to naught. However, on October 27, 1871, a meeting of the subscribers whose interest still survived reported that a sum of $3,000 had been offered for the university fund. Many whose interest outstripped their purses made their donations in terms of labor. The old site had never been deeded to the trustees, and general dissatisfaction called for a new location. After much voting and discussing, a plot of fifty-one acres on the heights to the south of the city was decided upon. Renewed efforts were made to secure funds; townspeople were appealed to; and rather against hope the legislature was asked to make an appropriation. Cash and labor subscriptions increased, and the committee invited "volunteers to a Bee to remove the surface stones from the University grounds." As a result of the new enthusiasm, on April 6, 1874, the governor signed an act appropriating $15,000 to the University, "this sum to be paid in two installments of $10,000 and $5,000 when the trustees should raise 'by subscription, donation, or otherwise' like amounts." Again the campaign was renewed; funds were solicited outside the state; and by June, 1875, the amount necessary was in the hands of the committee. The legislature paid its installments promptly, and the contract for a building was let for $28,700. On April 18, of the next year, the building known today as "'Old Main" was reported completed. Thus the University of Colorado had its humble beginning under territorial legislation. President Grant proclaimed Colorado a member of the Union on August 1, 1876, and by act of the legislature under the new constitution, provisions for maintenance of the University were made. Equipment was purchased, a course of study was laid out, and on September 5, 1877, sixteen years after the first legislative enactment, Dr. Joseph A. Sewall, president, and Professor Justin E. Dow, professor of Greek and Latin, took their places as "faculty" in the formalities which opened the University of Colorado.

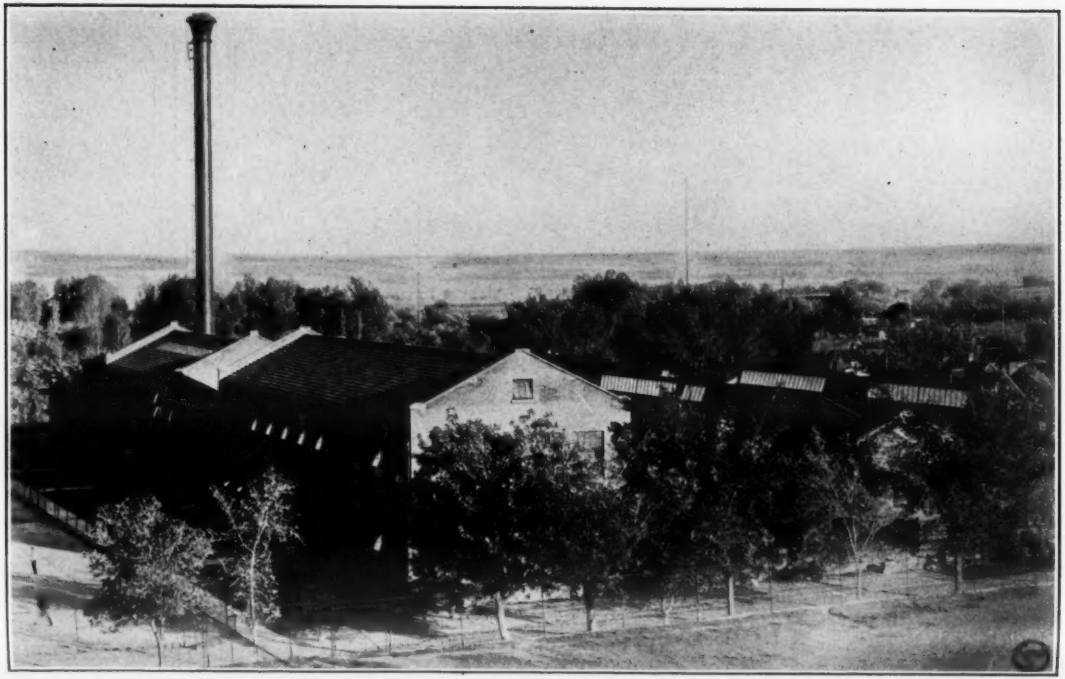


The steady growth which has characterized the University is due in no small measure to the far-sighted policies of its presidents: Dr. Sewall, who was succeeded in 1886 by Dr. Horace M. Hale; Dr. J. H. Baker, who was inaugurated in May of 1892; Dr. Livingston Farrand, who served from 1914 to 1918, when he resigned to assume the active leadership of the American Red Cross; and Dr. George Norlin, the present incumbent.

From two departments, both of which have been discontinued, the University has grown to include the College of Arts and Sciences, the School of Medicine, the Graduate School, the School of Law, the College of Engineering, the Summer Session, the College of Commerce, the College of Pharmacy, the University Extension Division, the Department of Home Economics, the College of Music, and the School of Business Administration.

Besides the 5,607 resident students, the Extension Division carries its services to thousands of people in the state through correspondence courses and through class instruction given in numerous communities of the state; through public service, such as home reading circles, library extension service, community health conferences, and business and governmental research; through business institutes conducted in cities of the state; and through the issuance of numerous bulletins and surveys on public and state problems. During the past five years the Summer School has increased its enrollment to 2,757 students, which ranks it seventh among the summer schools of the country.

In the construction of buildings, a program has been begun which aims not merely at furnishing sufficient floor space, but at having on the campus eventually buildings of only one type of architecture. This program, adopted in 1917, provides for an annual expenditure of $180,000 for a period of ten years and for buildings in the style of the Italian Renaissance. The New Arts Building and the Men's Gymnasium, the latter now under construction, are designed in conformity with this plan. The most expensive building scheme that the Univer-



sity has undertaken, however, is the new School of Medicine and Hospital in Denver, which will be completed by the fall of 1924. Erected at a cost of $1,850,000, the plant will consist of seven buildings and will accommodate 200 students.

Like that of the University, the early history of the College of Engineering is one of earnest pioneer efforts to meet the educational needs of a new and rapidly growing state. With his characteristic vision and perception of these needs, President James H. Baker stated in his biennial report of October 1, 1892: "It is apparent that the growing needs of Colorado and the future of the University demand a department which already exists in most state universities. I refer to a Scientific (Technological) School. The admirable work already done in the Scientific and Mathematical Departments is a foundation for such courses as are offered, for example, in Sheffield Scientific School. By the addition of one special professor, work in Civil and Electrical Engineering can be begun at once. In due time we shall aim at Mechanical Engineering as well as Civil and Electrical. The courses will be four years in length, and the College standard of admission will be required. . . . We believe that this school will become an important department of the University."

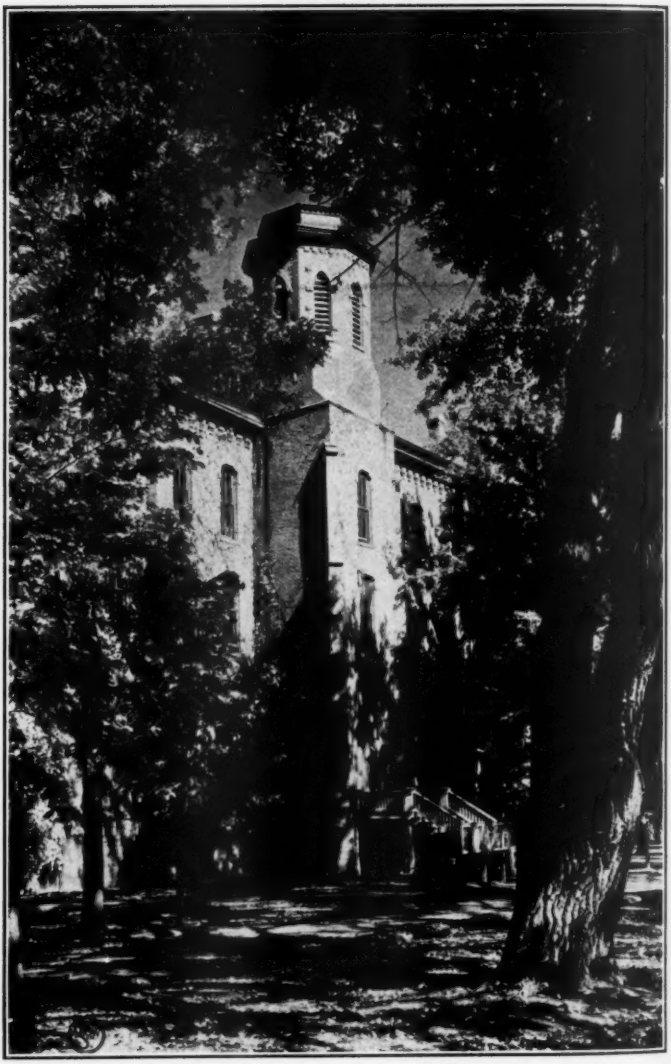
Upon this recommendation, the Colorado School of Science was organized in the winter and spring of 1893. It was opened in the following fall with a one-story, unpretentious brick building, the only tangible asset; one student; and a faculty of two: Major Henry Fulton, in charge of Civil Engineering, and Professor George H. Rowe, in charge of Physics and Electrical Engineering. Of the difficulties and discouragements of the early days, Professor Rowe writes as follows in a letter quoted by Dean H. S. Evans in the *Colorado Engineers' Magazine*, 1914: "It immediately became a problem of devising ways and means of giving all the courses we had advertised. The University had very little money. There was also much opposition from the older members of the faculty, who had no sympathy for any work outside of the old established 'humanities.' However, the Major got a few hundred

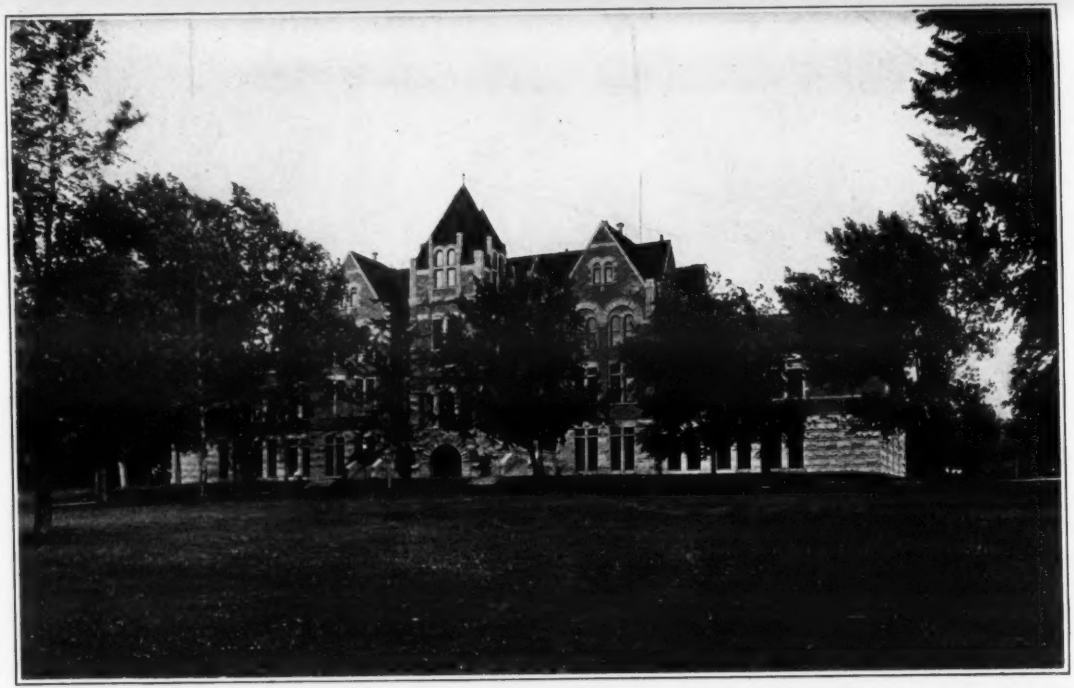
dollars for surveying instruments; and I secured a dynamo and a few lathes. Courses were thus started in wood bench work, wood turning, iron bench work, and iron turning. . . .

"These formative pioneer years would have been hard at best, but with almost no money, the work was at times disheartening. In 1895–96 the junior work had to be given. This necessitated more work, more apparatus, and more instructors."

Through the indefatigable efforts of these men, the School grew in spite of handicaps. Two years after its founding, in 1895, it was considered important enough to have a permanent dean, to which position Major Fulton was elevated. At the same time, Professor Rowe was relieved of his duties as acting head of the Department of Physics and was made Professor and head of the Department of Electrical Engineering. In this year, too, the name of the School was changed to that of the Colorado School of Applied Science, which name was retained until 1906, when it was changed to the College of Engineering of the University of Colorado.

Not for three more years, though, was the success of the undertaking apparent. "About the year 1898–99," writes Professor Rowe, "the affairs of the engineering school began to look bright; students were coming in good numbers, entrance requirements were made more rigid, and money began to come for buildings and apparatus." Perhaps the most formative period was between 1898 and 1905. The advance was not rapid, but it was certain and auspicious. In 1897–98, a second story was constructed over the entire engineering building, including a small wing that had been added in 1895. In 1902 another addition was built, and in 1903 two more were added. A four-year course in Mechanical Engineering was introduced in 1902, in charge of Professor H. C. Crouch, who later was succeeded by Professor J. A. Hunter, the present head. Two years later a four-year course in Chemical Engineering was offered. By 1905 the faculty consisted of nine members giving all their time to the School, and the student



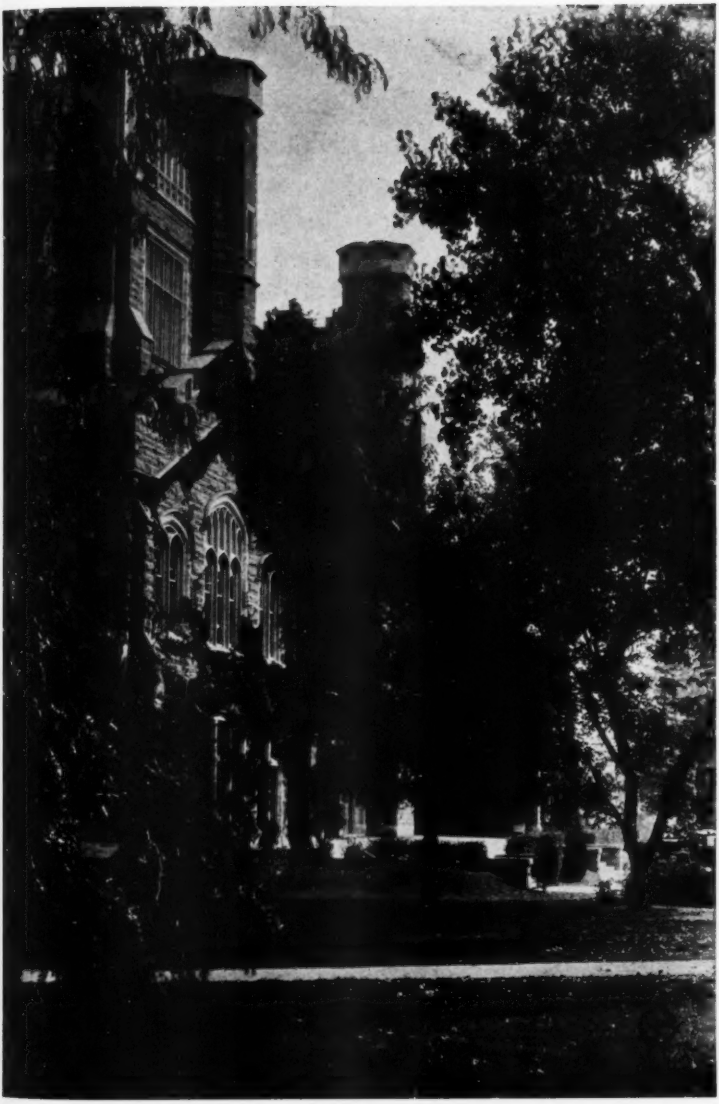


body numbered 173. More important was the splendid reputation that had been gained all over the state.

At the same time, this period was disheartening, because of numerous changes in the administration of the School. In 1901, when early difficulties were just being overcome, Dean Fulton died. Professor Rowe was elevated to his position, but resigned in 1903 to become Professor of Electrical Engineering in Leland Stanford. Professor H. B. Dates, of the Clarkson School of Technology, was then brought in as Dean and head of the Department of Electrical Engineering. Two years later, though, he accepted a professorship at the Case School of Applied Science. Upon his resignation, Professor H. S. Evans came as head of the Department of Electrical Engineering; and Milo S. Ketchum, who had been appointed Professor of Civil Engineering in 1904, was made Dean.

From 1905, under the direction of Dean Ketchum, the growth and influence of the School steadily increased. This was the beginning of stability and of evolving policies. Though many new members were added to the faculty, no major changes were necessary until 1919, when Dean Ketchum resigned to go to the University of Pennsylvania, and Professor W. C. Huntington was made head of the Department of Civil Engineering and Professor H. S. Evans was chosen Dean, in which capacity he now is ably serving.

Today, instead of courses in only civil and electrical engineering, a faculty of two, one small, inadequate building, and one student, four-year courses are offered in civil, electrical, mechanical, and chemical engineering; four buildings make up the engineering group, including the power plant, which is used for some laboratory work; the faculty consists of 59 members; and last year, 1922–23, the student body totaled 785 students, including 171 vocational trainees of the U. S. Veterans' Bureau. In the size of its student body, the College of Engineering ranks second in the University to the College of Arts and Sciences, thus fulfilling in a measure President Baker's prophecy in his report of 1892: "We believe that this school will become an important department of the University.



EDUCATING LEADERS AND ROUTINE PRACTITIONERS.

BY C. C. WILLIAMS,

Head, Dept. of Civil Engineering, University of Illinois.

Much discussion has been evoked from time to time on the matter involved in the above title. Some contend that our colleges should be concerned only with the education of leaders while others aver that colleges should train men to do the world's work efficiently and let the question of leaders take care of itself. May not the colleges effectively train both leaders and routine practitioners simultaneously, is a question that perhaps should be given further consideration.

There is a story told of a great philosopher who was very fond of the house cat and cut a hole in his library floor so that she might come and go at will. When she had kittens, he had a small hole cut in the floor so that they might come in also, the possibility of one large entrance serving for both sizes of cats not having occurred to him. To read some discussions that have appeared one might think that the possibility of gifted leaders and mediocre plodders coming through the same hole, *i.e.*, being trained in the same classes, had not been considered. The present writer believes that the two processes are entirely compatible and may be accomplished largely by the same instrumentalities.

Leadership will be recognized at once as consisting of two elements,

1. Scholastic leadership, depending on mental power, knowledge and skill.
2. Human leadership depending on character, facility of association, and knowledge of men.

It is obvious that leadership with regard to one of these elements will require different qualities and different training from that requisite in the other case, and that one might

be a leader in the one and not in the other, a rare man ranking high in both.

Scholastic leadership is required of those who wish to undertake investigations, teaching, or highly technical work, while human leadership is primarily necessary for the successful independent practitioner and the engineering executive.

In either case, the essence of leadership may be recognized as creative capacity. The ability to vizualize new situations and conditions and to forecast results by new combinations and applications of known factors or elements with regard to either materials, forces or men, constitute the service for which the public is most in need and for which it generally will pay the most liberal rewards. Not routine design or construction nor operation, but the new conception marks the leader. In other words, the student must become a *prime mover* himself instead of a mere *transmission line in* order to be a leader.

Most teachers probably recognize the validity of the above statement but differ as to how to achieve the desired results.

Granted that the aim of the college is to produce leaders as well as routine practitioners, how will the thesis that this double objective is to be accomplished affect our educational processes? What special treatment will be offered the gifted student?

A favorite proposal consists in segregating the specially gifted students into "honors sections" in which more ground may be covered and more thorough training afforded than can be accomplished by classes in common designed for average abilities. One of the foremost protagonists of this plan says,* "One of the great contributions from modern psychology is the discovery of the individual and the projection of his profile, here and there in quantitative terms, bringing to us the realization that in a given specific mental capacity one individual may have two, five, ten, twenty-five or a hundredfold the capacity of another with whom he is tied up in the

* Address by Dean C. E. Seashore, Baltimore, Nov. 9, 1922.

educational mold. Our curriculum and our campus sanctions are so effectively set that very often these individual differences are covered up or smoothed out so that the gifted individual as such is lost to himself as well as to society." He proposes sectioning according to ability as revealed in grade records as the remedy.

Whether sectioning according to ability will afford greater incentive to effort than will coveted " A " grades is a question yet to be settled. The discussing and explaining of subject matter by the superior students so that the less nimble minded members of the class can grasp it constitutes an exercise whose value in education is not to be overlooked. In a sense, " the small grains of sand polish the large pebbles " in the educational mill as now operated.

In the writer's opinion, there exists no such disparity of ability in students as measured by capacity to do quantity or quality of work as indicated by the above quotation. The most brilliant student will seldom do successfully 20 per cent. more than the average of the class, so that the maximum range of capacity is perhaps 1.0 to 1.4 instead of 1.0 to 100.0 and the ordinary range of grading (70 to 100) for passing accommodates approximately this range of achievement.

It is of course true that the gifted students can do certain things that the plodder can never do regardless of the time allowed, just as a superior high jumper may clear the bar at 6 feet while the mediocre athlete who is never mentioned cannot exceed 4 ft. 6 in., but there is no justification for the statement that the one can jump twice or one hundred times as high as the mediocre jumper. Indeed the general range of mental caliber of students bears a close comparison with their physical achievements on the athletic field, which has a range for normal men of about 1.0 to 1.3. The educational machinery designed to accommodate the average plodder and the gifted student at the same time should have a range of applicability, therefore, of perhaps 1.0 to 1.4 instead of 1.0 to 100.0.

Three difficulties occur in the actual application of "sectioning," In the first place, the criteria by which men of leadership caliber can be recognized and segregated are exceedingly uncertain, as any teacher of experience will testify. In the second place, gifted students in one course may be mediocre in another and the sections can not be arranged to accommodate the varieties of gifted students in prescribed curricula. In the third place, gifted students do not choose the "honor sections" because they know that more will be required of them and that they will have to work harder to secure an A grade than they would in the ordinary sections. Moreover, the superior section is inclined to "rest on its oars" and not do as good work as some of the other sections. At least, such has been the result where trial of the scheme has come under the writer's observation. None of these difficulties is insuperable, perhaps, yet they constitute serious obstacles to sectioning as a practical device. The writer believes the same results can be accomplished more simply by other devices mentioned later.

Closely connected with "honor sections" is the scheme of "honors courses" as followed at Oxford University and adopted in modified form in other institutions. Here a wide divergence exists between the "pass course" and the "honors course." In the former, the student largely takes his own time to earning the number of credits requisite for a degree and apparently there is considerable liberality in the grading of "pass" students. Students seeking the "honors degree" however must pass courses on time and creditably and the superior recognition coming to those holding the honors degree is sufficient to induce the good men generally to enter the honors course. The writer is inclined to believe that we would do well to pray to be delivered from the influences of any such system of "pass courses" and their ilk.

A modification of this "honors course" scheme is in vogue at Columbia University. Here "honor students" substitute "honor courses" for the prescribed work and are relieved

to a certain extent from the regular requirements, virtually allowing the more thoroughgoing courses to count for a greater proportion of credit. In addition, the honor students attend a seminar at which certain of the faculty members join in a discussion of the world's masterpieces, such as the works of Homer, Darwin, Adam Smith, Kant etc. It is hoped by this device to bring to those, destined by virtue of superior native talents to be leaders, an acquaintance with the common basic knowledge which educated men should have and which has radically influenced the world's thinking. The plan has much to commend it in theory, but the tendency to assign to the seminar work rather immature instructors who have not the background or perspective to make the exercise really stimulating to the keenest of undergraduate minds constitutes its chief defect, and the lack of homogeneity in the seminar is another element of weakness. Moreover, these discussion seminars have been too inclined to consist of a more or less blind faith in the efficacy of traditional culture and of a worship (already too long continued) at the shrine of the ancients. While knowledge of the world's classics is not to be disparaged, much of it might well wait, in the case of engineers, to the time of reflective readings which will likely engage their spare moments later in life.

Perhaps the most discussed mode of training for leadership in engineering is the lengthened course—giving more education, information, training or whatever it may be, of the same sort as included in the four-year course. Most of the advocates of the lengthened course have required twenty to thirty years in reading, experience and reflection to attain their present mental equipment and apparently they wish to attempt to incorporate most of this in the lengthened curriculum. At least, a ten or twenty year course would be required to attain the objectives implied in much of the current discussion.

The chief objections to a lengthened course are:

1. It is not necessary in order to secure the training requisite for most engineering work.

2. The further training required for research, difficult technical work and teaching can better be obtained by means of graduate courses leading to M. S. and Ph. D. under conditions of instruction where initiative and creative powers may be developed.

3. Lengthening the course to five years or to six years would increase the cost of educating an engineer 25 or 50 per cent. respectively, and neither the student nor the state can well afford this additional expenditure.

4. Beyond acquiring a certain amount of technical vocabulary, engineering education is chiefly concerned with habits of thinking rather than with engineering knowledge. Neither a five nor a ten year course would suffice to bring to the student the knowledge which he will need in his practical life. Proper mental habits that will enable him to solve his problems as they arise can probably be acquired in four years as well as in five or six where the additional years are devoted to miscellaneous subjects. Without adequate native talent and proper mental habits, neither a four years nor a ten year course would ever make a leader.

After this rejection of the various treatments of the "superior student problem" that have been proposed, is there a treatment that can be recommended?

In the writer's opinion the prevailing mode of grouping students of various abilities into the same classes is pedagogically sound. A four year course is necessarily concerned with fundamentals chiefly and the reiteration of these necessary to enable the plodder to pass benefits the superior student; also requiring the recitation by the gifted student to be so put that the plodder can understand constitutes a valuable educational method. Moreover, a student receives training or other benefit in proportion to his "specific capacity" or "absorbability characteristic," in any case, hence it is not necessary to segregate those with large capacity factor in order that they

may secure all that they can assimilate. The superior student gets 95 per cent. of that which is offered, whereas the plodder absorbs only 75 per cent.

Two devices may be suggested to afford superior students special advantages, neither of which requires segregation in regular class work nor serious addition to the teaching load. The first of these devices consists of "elastic assignments." By this term is meant the offering of additional assignments beyond those regularly required for passing which the superior students may do if they choose. Observation of the operation of this procedure leads the writer to a belief in its adequacy to meet the situation.

The second device is a seminar in which a few superior undergraduate students, certain graduate students and members of the faculty meet for discussion of such matters as may be selected by the professor in charge. These discussions may present a broader view of the matters involved or in other cases they may take on the nature more intensive studies into fundamental theory. The object of such a seminar should be to inculcate originality and discriminatory powers, to teach rational analysis and synthesis rather than to impart instruction. Leaders of thought from the faculty and the profession might be brought into the program of such a seminar. Papers or projects giving the solution of engineering problems characterized by creative genius would constitute proper subject matter. These should complete engineering projects rather than fragmentary problem assignments. New subjects about which little is known might be analyzed profitably. In the cases coming under the writer's observation, the principle involved in this scheme has proved sound.

In the final record, recognition of superior ability by the award of honors should be adequate. Through the failure on the part of colleges to recognize and distinguish properly the superior students, the students of their own volition have devised numerous so called honorary societies to supply this need. The multiplication of these societies has begun to

have rather serious consequences in some instances, although, the influence of one general honorary society, and perhaps departmental honorary societies in large institutions are probably beneficial. They constitute a "human laboratory" in which students mingle with and pass judgment on their fellow students and come to recognize qualities which promote success. They follow the careers of those chosen and thus have opportunity to note the reliability of the judgments exercised in the selection. The value of this self constituted "human laboratory" has not been fully appreciated in many instances, but to discuss it further is without the province of this paper.

From the foregoing it would appear that the gifted student does not present a problem requiring special radical treatment. It remains to be proved that the mode of teaching generally followed is not bringing to engineering students opportunities fitting their abilities as well as any that may be proposed when the existing uncertainty in evaluating capacity and ability at their stage of development is considered and that leaders may not continue to be produced as in the past. A good teacher will see to it that there is sufficient range in the requirements and that sufficient collateral work is provided in his class so that any who comes may receive to the extent of his capacity. Where additional training is desirable, it should be obtained as graduate work under optimum conditions for developing creative ability.

NOTES ON THE SCHOLASTIC TRAINING OF EMINENT ENGINEERS.

BY RAYMOND WALTERS,

Dean of Swarthmore College.

At the twelfth meeting of the American Association of Collegiate Registrars, held at Chicago this April, the Association voted to coöperate with the Commission on Curriculum of the Association of American Colleges in ascertaining the specific subjects taken in liberal arts colleges by a group of men who later became eminent engineers in accordance with the criterion of eminence used in a study made by the Collegiate Registrars in 1919-21. The Chairman of the Commission on Curriculum of the Association of American Colleges is Dr. Clyde Furst, Secretary of the Carnegie Foundation for the Advancement of Teaching, who is now obtaining transcripts of the college subjects of these engineers in connection with other material on which he is working. The present writer, who was chairman of the Board of Surveys of the College Registrars Association which made the study of the eminent engineers, has turned over to Dr. Furst the original data sheets desired.

A check-up of these sheets furnishes data as to liberally trained engineers beyond that given in the 1921 report published in ENGINEERING EDUCATION for April, 1921 (vol. XI, pp. 361-376). In view of the inquiry of the Society for the Promotion of Engineering Education into the aims and curricula of engineering education there may be interest in a summary of types of educational training of a group of men who have attained professional eminence in engineering.*

* The criterion of eminence employed by the Collegiate Registrars' study was the selection by the four "founder" engineering societies of their officers and important committees and representatives during the five years, 1915–1919, inclusive. The merits and short-comings of this

The following notes are accordingly respectfully presented for the information of the Board of Investigation and Coördination of the Society and of readers of ENGINEERING EDUCATION.

The study shows that, of 730 men on the list of professionally eminent engineers,

580, or 79.5 per cent., were graduates of engineering schools, colleges and universities;

35, or 4.8 per cent., had at least one year of collegiate training but were not graduated;

115, or 15.8 per cent., had secondary school training only.

A new analysis shows that of the 392 graduates of the 580 whose records could be studied in detail,

63, or 16 per cent. (of the 392), were graduates of liberal arts colleges;

40, or 10.2 per cent., were graduates of liberal arts colleges only;

23, or 5.9 per cent., were graduates of liberal arts colleges and also graduates of engineering schools.

The 63 graduates of liberal arts colleges held bachelor's degrees at least; 18, or 4.7 per cent. of the 392, held the doctor's degree. Additional statistics follow: B.A. degree alone, 9; B.S. (non technical) degree alone, 5; B.A. and M.A. degrees, 7; B.S. and M.S., 1; B.A., M.A. and Ph.D., 13; B.A., M.A. and Sc.D., 1; B.S., M.A., and Ph.D., 2; B.S., M.S. and Sc.D., 2; B.A. plus engineering degree, 17; M.A. plus engineering degree, 3; M.S. plus engineering degree, 2; Ph.D. plus engineering degree, 1.

Of the 63 professionally eminent engineers having liberal arts training 48 were (in 1921) engaged in technical work or executive work in engineering and industrial concerns; 15 were professors in technical schools or colleges, some of them being consulting engineers as well.

The foregoing statistics seem worthy of consideration *in connection with other factors* bearing upon the aims and types

arbitrary professional criterion are discussed in the report as published in ENGINEERING EDUCATION, April, 1921.

of engineering education. Taken alone they would be open to varied interpretation.

Statistics open to one interpretation only are furnished by this study as regards the relation between professional success in engineering and success in collegiate study. The original report gave the class standing upon graduation of all of the 392 eminent engineers whose collegiate records could be accurately determined. To this are now added the class standing of the eminent engineers having liberal arts training only, of those having both liberal arts and scholastic engineering training, and of those having scholastic engineering training only.

Taking the 329 eminent engineers having scholastic engineering training only, the records show that

140, or 42.5 per cent., stood in the highest fifth of their classes scholastically upon graduation;

96, or 29.1 per cent., stood in the second highest fifth of their classes scholastically;

64, or 19.5 per cent., stood in the middle of their classes scholastically;

14, or 4.2 per cent., stood in the next to the lowest fifth of their classes scholastically;

15, or 4.6 per cent., stood in the lowest fifth of their classes scholastically;

Of the 23 eminent engineers, having both liberal arts education and scholastic technical training,

14, or 60.9 per cent., were in the highest fifth of their classes on graduation;

3, or 13 per cent., were in the second highest fifth of their classes;

6, or 26.1 per cent., were in the middle fifth;

None were in the two lowest fifths.

Of the 40 eminent engineers having liberal arts education only,

28, or 70 per cent., were in the highest fifth of their classes upon graduation;

10, or 25 per cent., were in the second fifth;
2, or 5 per cent., were in the middle fifth;
None were in the next to the lowest fifth.
None were in the lowest fifth.

The table herewith affords a means of ready comparison of the foregoing figures, including also the numbers and percentages for the entire group of 392.

SCHOLARSHIP RATING OF 392 EMINENT ENGINEERS.

Class Rating upon Graduation.	Grand Total.		Engr. School Only.		Liberal Arts and Engr.		Liberal Arts Only.	
	No.	%.	No.	%.	No.	%.	No.	%.
Highest 20%.....	182	46.4	140	42.5	14	60.9	28	70.0
Second 20%.....	109	27.8	96	29.1	3	13.0	10	25.0
Middle 20%.....	72	18.3	64	19.5	6	26.1	2	5.0
Fourth 20%.....	14	3.6	14	4.2	0	0.0	0	0.0
Lowest 20%.....	15	3.8	15	4.6	0	0.0	0	0.0
Totals.....	392		329		23		40	

The results throughout show a marked relationship between good scholastic work and good professional work in engineering. For the men of liberal arts training, this is especially striking. These are figures that can advantageously be brought to the attention of young men, who, reasoning from a few instances, fancy that the student who does poor work or mediocre work has as favorable a chance for engineering eminence as the good student. These facts explode that notion.

ENGLISH DEPARTMENT.

A telegram has just reached the Chairman of the Committee on English as he prepares this note for the Bulletin, confirming the hope expressed in the April issue last that we are to have a joint conference of the Committee on English and Division of Deans and Administrative Officers at the Boulder meeting. This will afford an opportunity for the deans to tell us what they want by way of training in English for their students, to commend us for our honest efforts, and, we hope, to point out with kindly frankness wherein we have failed. I hope we may have a representative number of English teachers present, for this first conference of our deans at which the place of English in our scheme of Education is to be their theme, marks an historical occasion. Judging from the response to the questionnaire sent out by the Committee on English to the deans a few months since, there is everywhere among administrative officers in our engineering schools a growing concern regarding this matter of training in English for our students. Replies have come all the way from Porto Rico and Honolulu to Alaska and Saskatchewan. If even a small proportion of the deans who have written us are present at the Boulder conference on English, the session should result in very profitable discussion. No program of topics for consideration has yet been made. We are only agreed that there shall be no set speeches nor prepared papers, but only the most frank and informal discussion of the place of English in the engineering curriculum, the kind of training in English most likely to be useful to our students, and the opportunity which courses in English afford for stimulating their development.

The English Committee would appreciate it greatly if any of the deans who plan to attend the joint conference on English in June would write the chairman suggesting topics which they would like to hear discussed at that session.

Address J. Raleigh Nelson, 927 Forest Ave., Ann Arbor, Mich.

THE FRESHMEN.*

BY C. L. WHITE,

Freshman Adviser, University of Washington.

All of us who have sympathetically watched and endeavored to assist freshmen in their adjustment to college work, will agree, doubtless, that the job is of respectable magnitude both for them and for us.

Their previous training has not involved, to a habit-forming degree, the careful, systematic, clear presentation of the conditions of a problematic situation and the equally clear setting forth of the steps in its solution. Nor has their experience developed, to any discernible extent, the power of discrimination between the general basic essentials underlying a problem and the special incidentals of its setting. By the expression of this thought there is intended no specific criticism of their previous training or experience, but certainly they have reached that stage of mental development which if properly directed will enable them to study independently. It is not surprising that they find the experience at first baffling and somewhat painful, for the record of the inability to recognize fundamentals in all fields constitutes a large portion of human history. On the other hand my observation of many instances shows that the satisfaction and real benefit derived by a student from actively exercising his mental powers in handling a situation, which, a short time before, he little supposed he could handle without the aid of a massive volume of information, far exceeds the pleasure and utility to be gotten from the passive absorption of material prepared for him.

Our experience with the freshmen leads us to the practically universal conclusion that the most immediate need is training in better habits of both work and study; the normal reaction from high school liberal studies renders the fresh-

* To be presented at the annual meeting.

man year a propitious time to initiate the remedy for this lack of needful habits. Such training we consider as capital outlay for permanent equipment, the return on which is the increased yield from the intellectual effort of subsequent years. We have been providing it for a sufficiently long period, some seven years, to feel confident that our appraisal of the results affords a sound basis for the conclusion that the time given to it is well spent.

If this training be imposed as a thing apart, and detached, it becomes intolerably irksome, the driving force having to be supplied continually from without. A better plan is to make it an inseparable part of work which intrinsically has a strong appeal to the student's interest and which he recognizes as an essential part of what he is seeking. The effectiveness of all his subsequent work is increased, a desirable confidence in the use of mental powers is nurtured, his sense of professionalism is aroused, and the idea of remoteness of benefits is decreased, when at the outset of his course he is given an insight into the nature of engineering, in appreciation of the engineer's method of attack and solution of problems, and some training in systematic performance and recording of work. In this connection the following consideration is of great importance; a rigid insistence upon unremitting conscious effort in perfecting habits of careful, clear and systematic work when judiciously mixed with material of interest is responded to in good spirit and without question by freshmen, while the same procedure would undoubtedly arouse resentment in upper-classmen.

We have found ideal agencies for accomplishing these objects in general engineering drawing and engineering problems. These courses require an equal amount of time, each, seven class room hours per week. The Colleges of Engineering and of Mines have a common freshman year as follows:

FRESHMAN

Autumn Quarter	*Credits*
Alg. Math. 51	4
Engr. Prob. C.E. 11	3
Gen. Chem. 1 or 21	5
Drawing, C.E. 1	3
Mil. Sci. or Phys. Ed.	1⅔
	16⅔

Winter Quarter	*Credits*
Trig. Math. 52	4
Engr. Prob. C.E. 12	3
Gen. Chem. 2 or 22	5
Drawing C.E. 2	3
Mil. Sci. or Phys. Ed.	1⅔
	16⅔

Spring Quarter	*Credits*
Anal. Geom. Math. 53	4
Engr. Prob. C.E. 13	3
Gen. Chem. 3 or 23	5
Surveying, C.E. 21	3
Mil. Sci. or Phys. Ed.	1⅔
	16⅔

The weekly time given to surveying is the same as that required in problems and drawing, so that during six quarters of work our freshmen have close contact with engineering subject matter. Close supervision is maintained continually in these engineering courses and all of the work is strictly individual except at such times as the instructor directs general discussions. This policy must be modified in surveying field work.

The drawing and problem courses are conducted along similar lines with this difference in aim recognized, that in the problems course we are not attempting directly to make any considerable addition to the student's fund of subject matter, but rather we are affording him the experience of studying a

situation which objectively he is adequately prepared to handle, being in possession of the fundamentals underlying it, but for the analysis and solution of which he must attempt his own mental organization under the instructor's coaching and guidance.

However, since the immediate formation of good habits in actually performing the work in both courses is of such vital importance, and since the principles underlying orthographic drawing are so few in number, it works out that for the first quarter the methods are quite similar.

We have found it possible to bring the class, as a whole, to an acceptable technique in less time and with more lasting benefit, by requiring the standard of all work in both the problems and drawing courses to be the same. This result is in harmony with the fact that it is the permitted recurrence of exceptions that militates most strongly against the formation of habits. The work is conducted in such a manner as to prevent the growth in the student's mind of the idea that habits of carefulness, neatness, good form and system may be discarded and successfully put on at will.

The student's equipment includes Carnegie Pocket Companion or other source book, and a slide rule. A uniform system of layout, on standard paper, designed to facilitate orderly solution of problems and marking of papers, is used. Good lettering, neatness and clearness, plain sketches and strict adherence to standards adopted, are insisted upon continuously from the beginning and are considered in grading.

After a start has been made and the need for help is realized a simply written book dealing with the laws of habit formation and mental operations and conditions for effective study, is added to the student's equipment. The instructor finds this helpful in convincing the student that the requirements are reasonable, based on good authority and necessary to the progress which he, himself, desires.

Our first effort in drawing is to familiarize the student with properly grouped flat or two dimensional views since all his

previous experience has been confined to views indicating depth or three dimensions. The processes involved are the analysis of his old conception into coördinate dimensions and the assembling, or synthesis, of the orthographic views into a clear mental image of the object drawn. This is effected largely by problems involving the computing of the cost from unit prices of objects or structures from their engineering drawings and by reading exercises given as problems. Such definitions as are necessary to conserve the student's time are given to him. The solving of a great many problems under intelligent and careful supervision by one who knows when to give and when to withhold aid, seems to be an effective way of gaining a lasting conception of a principle and its application. The second quarter's work in drawing must of necessity diverge somewhat from the problem work because it consists so largely of training for skill in execution, yet here we have found that more rapid improvement comes from the satisfactory completion of many small jobs than from long jobs done in an unsatisfactory manner. It is impracticable to reject the long job as a whole and require it to be done over, consequently imperfections will remain; but a job requiring only a period or two may be condemned entirely in the interest of a proper standard.

In the problems courses the principles of mechanics form a very convenient frame on which to hang our work because the laws governing the action of physical forces upon material bodies, underlie all engineering. Two thirds of our work takes its setting from situations involving motion equilibrium; the remaining portion deals with dimensioned space conceptions and problems involving metric properties, including the reading of actual engineering drawings.

The problems are taken out of engineering situations. A few involving a complete plant or structure are introduced to provide exercise in resolving the situation into its components parts. Solving the elements extracted from the larger situation constitutes a considerable portion of the work. We

have found it often advantageous to introduce situations whose complete analysis is admittedly beyond the ability of the freshmen, for this serves as motivation for continued effort. Such a situation provides a setting for some particular portion which is solved completely.

Simple design problems are also used in order to include the processes of synthesis. Throughout the whole work, which necessarily has recourse to the theoretical, there is maintained as close a connection as possible between the problem in hand and features of engineering works with which the student normally is familiar. There is usually some University building or public bridge near-by under construction which provides a fruitful source of problems. Some of the most interesting work is based on data obtained in the materials testing laboratory taken in the presence of the class.

Our freshman problems course itself is an outgrowth of Professor C. C. More's work in developing the teaching of mechanics by problems. Since detailed descriptions of this work have appeared in the Society's publication and elsewhere, it will be recalled that the salient feature of the method is the requirement that a given problem, or problems, must be worked individually by the student during the class period, under the coaching of the instructor. The effort to meet the needs of freshmen in recent years has resulted in placing greater emphasis upon the element of training for good form, and effective study, than is indicated by the earlier accounts.

When the need is first recognized the student is given the laws of motion and of static equilibrium and is permitted to verify and use three laws of rate curves. We have found the latter to be of immense service in giving the student an additional avenue of approach, serving at the same time to develop the indispensable habit of checking. They constitute an excellent device for continuous drill in the application of arithmetic, geometry and algebra, thereby aiding the coördination of the student's whole store of mathematical knowledge.

They provide a means for training in clear sketching which is a prime requisite in the solution of problems. They afford simultaneously mathematical, graphical and physical conceptions of any problem involving rates or quantities having a fixed dependence upon other quantities. As a practicable introduction to the field of graphics rate curves are unexcelled.

For the third quarter's work the simple principles governing the construction of the view of an object from any desired position, are given to the student and proved by him. In this course we have an actual coalescence of the problems and the drawing. The field is replete with situations inviting the student's ingenuity. The longer problems, which require more than three hours, are graded for technical execution only, provided the solution is correct. Coöperation outside of the class period is encouraged; consequently all these problems are usually solved correctly although it is interesting to note that the solutions vary widely. The description, of the solutions, in clear accurate and concise English, form an important element in this quarter's problems.

The problem work lends itself admirably to quantitative evaluation of achievement and this quality is utilized in administration and in the freshman advisory work. During the last year the Freshman Adviser was in direct charge of drawing and problems. The student scores at every meeting of the class, all instructors use closely coördinated material and mark on a uniform basis. Satisfactory coördination does not require the use of the same problem but merely problems dealing with the same phase of the work. A short weekly conference of the instructors is sufficient to secure this. An acceptably uniform basis for grading is obtained by marking each problem on a scale of ten for numerical results, with a multiplying factor ranging from zero to one representing the extent to which the paper conforms to stand required.

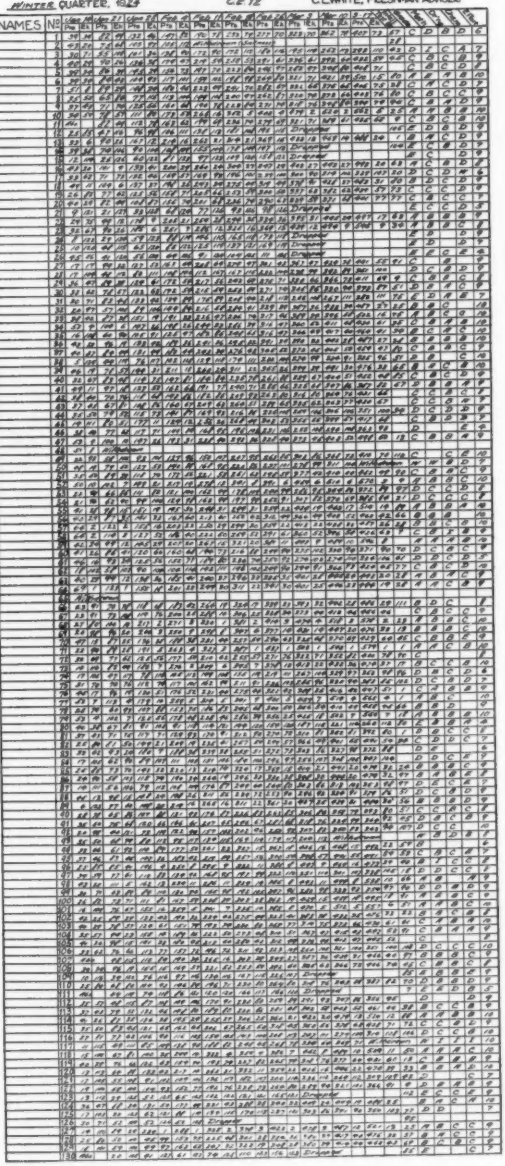
We have usually, for the first quarter, eight sections meeting on the same days—four in the morning and four in the afternoon. This generally is reduced by half in the spring

quarter. At the end of two weeks those sections meeting simultaneously are resectioned on the basis of ranking within the sections, section A, for instance, receiving the highest quarter from sections A, B, C and D; section B the next highest, etc. Thereafter, at the end of every two weeks the highest one fourth of every section goes to the next higher section and the lowest one fourth to the next lower section. At the same time the instructors are shifted. We find this method of resectioning and shifting productive of benefit to the freshmen, by extending and deepening their acquaintanceship among their fellows and among the instructors. It conduces to the growth of self-reliance and initiative, by placing the student in problematic situations under several instructors; it reduces the effect of the personal equation in marking, to a negligible minimum and thereby convinces the student of the justice of his final rating. The scheme is an excellent aid in promoting a desirable coördination of the work. The reflex action upon the instructor, since he knows that he is subject to comparison in the minds of the whole class, tends towards justice and extreme care in marking. This tendency does not obliterate personal differences in severity and leniency nor does it produce uniformity of emphasis; but the distribution affects all members of the class fairly equally. It is doubtless true that not all courses are adaptable to such a degree of coördination as this constant resectioning demands but because of the fact that we are dealing with only a few principles, however varied the settings may be, the requisite coördination is easily achieved.

Each member of the Freshman problems class is assigned a number known to him and to the instructors only. The numbers are then posted on a chart placed on the bulletin board in the main hall. This chart is shown on the opposite page. In order to enhance its value for filing purposes as well as for comparison, there is also recorded on the chart the student's intelligence test score, his grades in other subjects and the instructors' estimate of a characteristic. Regu-

ENGINEERING PROBLEMS

WINTER QUARTER, 1924 — C.E. 12 — C.L.WHITE, FRESHMAN ADVISER



lar students will appear on three such charts for the year. At the end of every week each student's numerical standing, which is a cumulative quantity through the quarter, is written on the chart together with his rank. The grades are reduced to points on the basis of 10 points for the one hour period and 30 points for the three hour period; consequently, no period is devoted wholly to discussion. On the basis of the first three weeks' work the class is divided into groups of an equal number (usually about 16 men) with as nearly as possible the same total standing. The personnel of these groups remains unchanged for the quarter. The student with

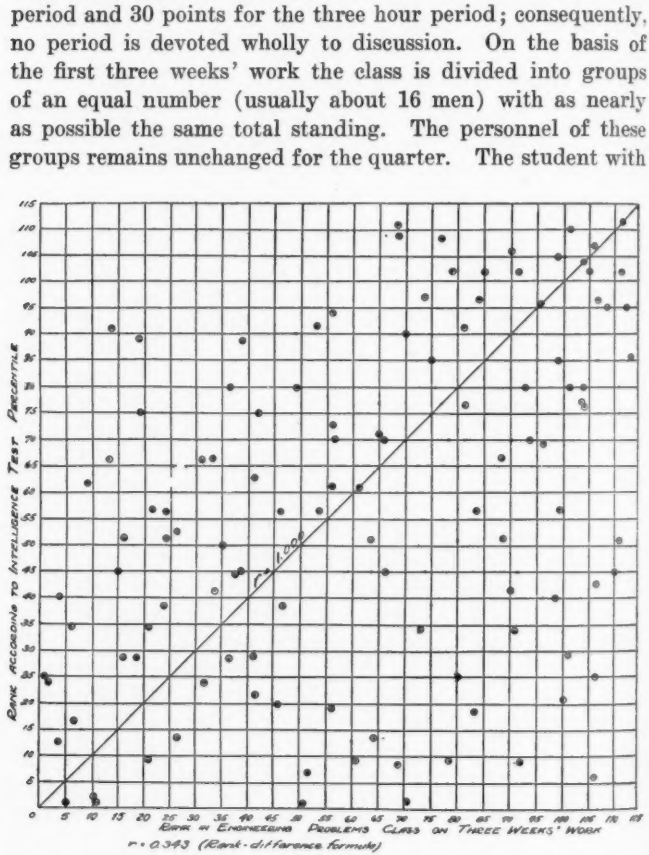

Rank according to Intelligence Test. Percentile
Rank in Engineering Problems Class on Three Weeks' Work
r = 0.343 (Rank-difference formula)

FIG. 1.

highest standing at the time of grouping is made Captain and the names of the rest of his group revealed to him. The purpose is to promote closer contact among the freshmen and to present to them an opportunity for development in organization, self-help and desirable coöperation. Enthusiasm is quickened by an appropriate recognition of the winning group. In addition to the publicity afforded by the college paper, this recognition has taken the form of an invitation, as guests of honor, to the Tau Beta Pi initiation banquet for the highest quarter of the group and usually an engineering inspection trip, on school time, for the whole group. This acquaints the freshment with the existence and function of Tau Beta Pi and puts the fraternity on its mettle to appear as something worth while. Thus the problem confronting the group might well be designated as one in " human engineering " involving the assumption of responsibility for the object is to get maximum product from each member. The intent is to arouse and develop simultaneously competitiveness and coöperation. We have sectioned on the basis of ability for the whole of last year and have utilized the chart for the last two quarters. All of the benefits following such sectioning that have been recorded when applied to other classes are derived in amplified measure when applied to problems classes. The chart has proved quite effective in stirring up interest, stimulating effort and keeping enthusiasm alive. It also renders a large portion of administration automatic, as it were, and entails a very slight cost for clerical labor.

As Freshman Adviser during the last four years I have tried out various plans and devices for obtaining knowledge of the students' characteristics and for utilizing that knowledge for the students' benefit while they are yet freshmen but the resectioning and the chart give a maximum result with a minimum labor cost. They certainly put what the boys expressively term a " kick " into the work. Because the requirements of the engineering field are so varied it is hardly just and certainly not wise to urge a Vocational decision

wholly upon the reaction to quantitative problems without reference to other considerations.

Two diagrams showing the intelligence test correlation, one at the end of three weeks, and one for the final ranking, are reproduced. It is interesting to note the movement to points toward upper left-hand corner in diagram No. 2. Undoubtedly these students were applying themselves very intensely. Practically all the men in the last two columns to the right on this diagram, were dropped a month before the end of the quarter. A normal load was too much for those in reasonable correlation, while the others seemed to lack sufficient stamina for sustained effort along the line required.

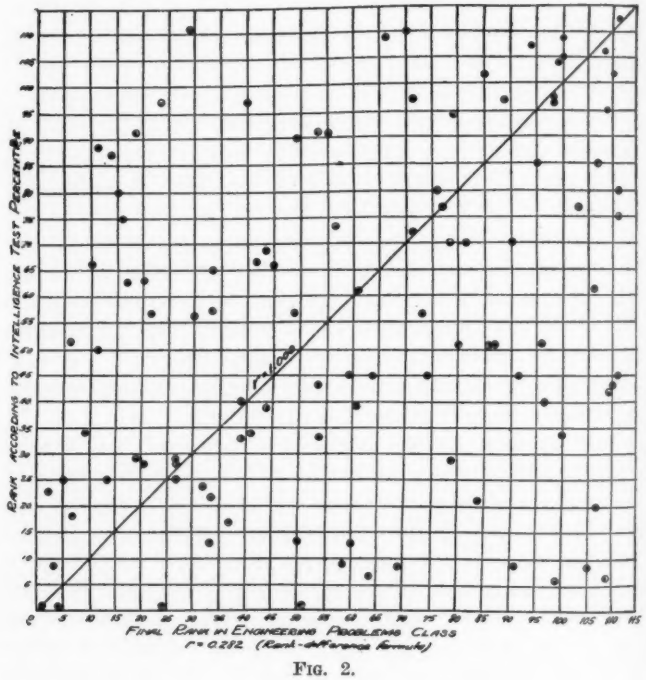

Rank according to Intelligence Test Percentage
Final Rank in Engineering Problems Class
r = 0.282 (Rank-difference formula)

FIG. 2.

The results afford a reasonable basis for expecting that considerable more can be accomplished in cleaning out the lower right-hand corner than appears on diagram No. 2. During the Spring quarter, at the end of the first week, we posted a large scale diagram with each point numbered in accordance with the students' numbers, on the ranking chart, so that unfavorable correlation was plainly evident in ample time for insistence upon a change. This phase of the work has been developed only during the last year but it promises to be fruitful in interesting and instructive data.

In addition to the assistance in orientation and guidance afforded personally by the Freshman Advisor, early in the year Dean Magnusson and Dean Roberts talk to the engineering problems classes during scheduled time, upon the general extent and nature of engineering and its requirements. During the winter a printed outline of the field, the opportunities and expectancy in the various branches of engineering, is placed in the hands of the freshmen. In the spring this outline is supplemented by talks on illustrative instances and incidents of personal knowledge from faculty members of all departments. These require from fifteen to thirty minutes and are given during some regular three-hour period of the problems classes. It is manifestly impracticable to attempt to portray completely the nature of engineering to freshmen through the medium of problems requiring almost exclusively quantitative thinking. We find it possible, therefore, to make this feature of talks by faculty representative productive of interest, inspiration and incentive, because they present the more human elements in problems confronting the student. Incidentally they also may be made the means of benefit to the faculty by affording them the opportunity of gaining a more sympathetic vision of the freshman's problem of evaluating remote and immediate benefits, personal gain and community service, the rewards of business shrewdness and of intellectual effort.

In checking the lists of freshmen who decide to continue

their study of Engineering our records show a gratifying increase in the number of good men who return. Under our present condition of limited finances we are more pleased than otherwise by the decision of the men of poor scholarship not to return, however much we may deplore our inability adequately to serve all who desire college experience.

In placing a freshman under the operation of University rules for maintenance of academic standards that will prohibit his return to college, we feel added confidence in our action when supported by a record made under the system outlined and by the combined judgment of the several instructors having personal knowledge of the student.

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